

FOREST BIOENERGY

December 05, 2017



Background

- ACC Rate Order required APS to evaluate increased forest bioenergy as part of its portfolio and report back to the Commission within 90 calendar days.
- Scope of Order requirement included:



Scenario Development



Forest Acres Affected



Environmental Benefits



Adjustments to APS's
Revenue
Requirements or PSA



Projected Water Savings



Forest Thinning Activities



Input from Stakeholders

APS Perspective

- APS supports:
 - The evaluation of initiatives that can improve the lives and safety of Arizona residents.
 - Efforts that could lead to healthier forests, including this discussion about forest bioenergy and its role in Arizona's energy mix.
- This report was completed in 90 days and provides a high level assessment of the opportunity and risks/challenges. A more complete assessment of the opportunity plus potential risks/challenges is necessary to be fully informed.

Evaluation Methodology

- APS engaged Black & Veatch to help with the technical assessment of woody biomass availability, transportation cost, permitting, and technology cost and performance.
- APS utilized the Black & Veatch inputs to evaluate portfolio and cost impacts based on the 2017 IRP Flexible Resource Plan.

DETERMINE
BIOMASS
AVAILABILITY



DEVELOP
COST
ESTIMATES



IDENTIFY
POTENTIAL
LOCATIONS



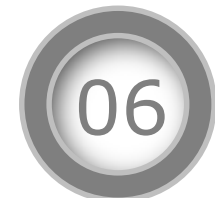
DEVELOP
THREE
SCENARIOS



EVALUATE
PROJECT
IMPACTS

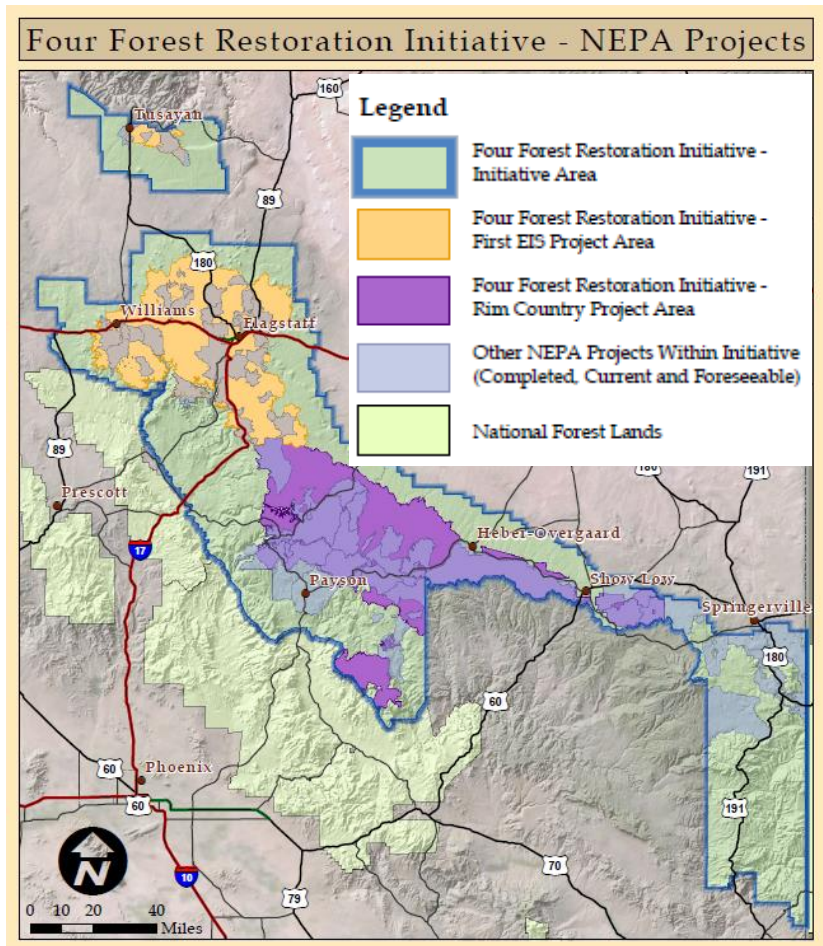


EVALUATE
APS & CUSTOMER BILL
IMPACTS



Forest Bioenergy Scenarios Development

- Scenario Development Criteria
 - NEPA-approved and expected to be approved target to clear approximately 1 Million acres over a 20 year period or 50,000 acres per year.
 - Technical evaluation of forest fuel availability over a 20-year period.



Forest Bioenergy Scenarios

Details

	Low-Use	Medium-Use	High-Use
Novo BioPower*	27 MW	27 MW	27 MW
30 MW Plant	30 MW	--	30 MW
60 MW Plant	--	60 MW	60 MW
Total MW	57 MW	87 MW	117 MW
Forest Acres Affected	24,000	34,000	48,000

*All scenarios assume continued operation of the 27 MW Novo BioPower forest bioenergy facility located near Snowflake, Arizona that began commercial operation in 2008. Its output is sold under a purchased power agreement to APS and Salt River Project, with APS receiving 14 MW of the plant's output.

Develop Cost Estimates for Forest Bioenergy Generation Resources

- Black & Veatch reviewed a variety of technologies to facilitate forest bioenergy electricity production.
- Bubbling Fluidized Bed (BFB) technology was selected to be the base scenario for new build forest bioenergy resources.
- 30MW and 60MW forest bioenergy facilities were evaluated to meet projected forest thinning initiatives.
- Costs of a 20-year project ranged from approximately \$180 to \$200 per MWh depending on scenario, assuming dry cooling.

Forest Bioenergy Benefits

Healthy forests benefit everyone in Arizona

- Job Creation

Low-Use
Scenario

Temporary Jobs: 1,362
Permanent Jobs: 114

Medium-Use
Scenario

Temporary Jobs: 2,114
Permanent Jobs: 136

High-Use
Scenario

Temporary Jobs: 3,495
Permanent Jobs: 250

- Maintaining healthy forests – including reducing the threat of catastrophic wildfires – enhances the quality of life for the residents and wildlife who live there and helps Arizona's economy.
- Healthy forests protect the reliability of the state's energy grid by decreasing the risk from heat, smoke and flames that could lead to outages of major transmission lines.

Forest Bioenergy Challenges And Risks

- Increased forest bioenergy resources could result in increases of between \$1.54 and \$4.13* in monthly bills for the typical residential customer.
- Growth of solar energy continues to increase the need for flexible resources and decrease the need for less-flexible baseload resources, including forest bioenergy.
 - Adding more baseload resources may prompt the need to sell forest bioenergy power at negative prices in wholesale markets during times when production exceeds customer needs.
- The required 20-year fuel commitment has several supply-related risks including NEPA forest restoration process, lumber commodity prices and potential wildfires reducing fuel supply.
- Potential opposition to permitting and constructing new forest bioenergy plants may exist in environmentally sensitive areas. Air permitting process requires the longest lead time with overall plant development expected to take approximately four years.

Potential Next Steps

- A next phase of review to include the following:
 - High level assessment of the ability to include Piñon-Juniper
 - Exploration of alternatives to lower the overall costs
 - Ability to mitigate baseload impacts through alternative design and operation
 - Risk assessment of 20-year fuel source
 - Potential feasibility of forest products industry
- Collaboration with stakeholders on mechanisms to mitigate the cost burden to customers including potential sources of federal and state-wide funding.

APPENDIX

Project Impacts

	Low	Medium	High
Power Generation (MW)	57	87	117
Energy (MWH/Year)	424,000	648,000	871,200
Forest Acres Affected (Acres/Year)	24,000	34,000	48,000
Job Creation (Temporary)	1,382	2,114	3,496
Job Creation (Permanent)	114	136	250
Environmental Benefits	Reduces potential for crown fires; promotes vegetation composition, diversity and resilience; improves understory production and nutrient cycling; increases roosting and nesting habitat		
Water Impacts	Reduces potential for negative water quality impacts associated with catastrophic wildfires; slightly increases water yield; increases winter snow pack		

Cost & Performance Factors Overview

Parameter	30 MW	60 MW
Capital Cost (\$/kW)	7,045	5,405
Capital Cost (\$Millions)	211	324
Delivered Feedstock (\$/MMBtu)	2.50	2.19
Heat Rate (Btu/kWh)	14,500	13,400
Fixed O&M (\$/kW-Year)	159	77
Variable O&M (\$/MWH)	9.65	9.55
Levelized Cost of Energy (\$/MWH)	217	184

^[1] All costs except the Levelized Cost of Energy are shown in 2017\$ and are based on dry cooled technology. Capital cost excludes AFUDC. Levelized Cost of Energy is leveled over 20 years from 2021 to 2040 and is based on APS's cost of capital and capital structure.

^[2] There are efforts under way to increase drying time allowed for woody biomass in the forest before it is transported to the power plant, and to increase weight limits on trailers hauling this fuel source. To the extent these efforts are successful, the cost of transporting woody biomass from the forest to the power plant may be reduced. 13

APS System & Customer Bill Impacts Overview

	Low	Medium	High
APS Bioenergy Assumed (MW)	44	74	104
Energy (MWh/Year)	326,000	550,000	773,000
Bioenergy PPA Cost (\$/MWh)	198	178	190
Net Revenue Requirement (NPV, 2021 \$ Millions)*	457	670	1,030
Net Residential Customer Cost in 2021 (\$/Month)*	1.54	2.57	4.13

*These would be collected through the Renewable Energy Surcharge and/or Power Supply Adjustor (PSA) for purchased power agreements, levelized.